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THE MOUNTAIN PINE BEETLE
"DENDROCTONUS MONTICOLAE HOPK."

prepared by

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WHAT IS THE NAME OF THE INSECT WHICH KILLS MATURE WHITE PINE TREES IN IDAHO AND MONTANA?

Its common name is the mountain pine beetle. Its scientific name is Dendroctonus monticolae Hopk. The word Dendroc-to-nus means "killer of trees," while mon-tic-o-lae is taken from the scientific name of white pine, or Pinus monticola. The last word, "Hopk," is an abbreviation of Hopkins, the man who first recorded and named this species.

WHY ARE SCIENTIFIC NAMES OF INSECTS NECESSARY?

As the common names of insects vary for different localities, it is necessary to have one recorded name that can be used in order to avoid confusion. As an example, the mountain pine beetle is often called white pine beetle, pine beetle, lodgepole beetle, pine engraver, etc., and as these names are also applied to other beetles, considerable confusion occurs. This is avoided by referring to the scientific name.

IN WHAT PART OF THE UNITED STATES IS THIS INSECT FOUND?

The mountain pine beetle is found throughout the States of Oregon, Washington, California, western Nevada, Idaho, western Montana, and northwestern Wyoming.

HOW DESTRUCTIVE IS THIS INSECT?

Within the forests of Idaho and Montana, epidemics of this insect during the past ten years have destroyed approximately 110,000,000 B.F. of white pine, and 5,000,000,000 B.F. of lodgepole pine. On one forest in Montana over 17,000,000 trees were killed during the 1933 season. The epidemic responsible for this destruction has also destroyed a large percent of the mature lodgepole pine stands of Idaho and Montana. In these devastated lodgepole pine forests one may travel for miles through dead forests.

DOES THIS INSECT ATTACK OTHER TREES BESIDES WHITE PINE AND LODGEPOLE PINE?

The mountain pine beetle attacks white pine, lodgepole pine, sugar pine, ponderosa pine, whitebark pine, limber pine, and sometimes Engelmann spruce when it occurs in association with pine.

OF WHAT IMPORTANCE IS THIS DESTRUCTION?

In addition to the monetary loss of the timber itself, there are such intangible items as the creation of dangerous fire conditions, loss of scenic values, watershed protection, game protection, etc.

When epidemics of the mountain pine beetle occur in lodgepole pine forests, a large percentage of the stand may be destroyed. These standing dead trees go down in the course of a few years, making an impenetrable tangle of

logs and tops. Under proper conditions a flash of lightning or a carelessly tossed match or a cigarette may set off the mass, resulting in a widespread conflagration almost impossible to fight.

Old snags of insect-killed trees, often as many as 10 per acre, scattered throughout our mature forests stand for many years, and greatly increase the danger of fire control. Snag-felling is now required in many sales of National Forest timber, and many private operators have also adopted this regulation. The increased cost of control of fires which have spread from burning snags within fire lines would alone justify insect control even at a high cost.

The importance of adequate forest cover in National Parks, recreational areas, and game preserves cannot be estimated in monetary values. Here the scenic and protective values far exceed that of the commercial timber.

Another less appreciated phase of the activity of the mountain pine beetle is the part which it plays in changing forest types. In both white pine and lodgepole pine forests this insect, through its destructiveness, so affects the proportion of species in these stands as to convert the resulting forests into one of an entirely different composition.

WHAT IS THE MOUNTAIN PINE BEETLE LIKE?

The mountain pine beetle is a rather stout, cylindrical beetle varying in length from .2 to .35 of an inch. The immature stages of this insect are egg, larva, and pupa. The larva when full grown is about the same size as the beetle, and is white and legless, with a small, yellow head. The pupa, or the transition between the larva and new adult, is also white. The pupa gradually assumes the form, shape, and color of a new adult.

HOW DOES THIS INSECT DESTROY A HEALTHY TREE?

The female beetle bores through the bark and constructs a long, perpendicular gallery directly beneath the bark, slightly grooving the surface of the wood. At the bottom of these galleries, which always extend up the tree, there is a short crook, or bend, an inch or two in length. The perpendicular portion of the gallery, which varies in length from 9 to 36 inches, nearly always follows the grain of the wood.

During the construction of this gallery eggs are deposited in small niches along the sides. These eggs hatch in a few days into small grubs, or larvae, which excavate short feeding tunnels at right angles to the egg gallery. The feeding tunnels vary in length from one to three inches, and are exposed on the inner surface of the bark. When fully grown the larva constructs a small pupal cell at the end of the larval mine, in which it transforms to a new adult. This transformation is what is called the pupal stage. The galleries constructed by this insect result in the girdling of the tree, which causes its death.

HOW MANY OF THESE ATTACKS ARE REQUIRED TO KILL A HEALTHY TREE?

The number of these beetles required to kill a healthy tree depends entirely upon the size and vitality of the tree attacked. Under normal conditions the number of attacks per square foot of bark surface varies from seven to eleven, with an average of nine.

HOW RAPIDLY DO THESE INSECTS INCREASE?

Though normally there is but one generation of the mountain pine beetle each year, during long seasons there is often a partial second in white pine and ponderosa pine. By generation is meant one brood from egg to adult. Each female will lay from 60 to 80 eggs, which with equal number of males and females would give an increase of one to thirty or forty. Though this is the maximum potential increase each year, it does not occur, which is indeed fortunate. Such an increase would mean forty trees attacked this year for everyone attacked last year, and so on until all our pine would be destroyed in a very few years. There is a very high mortality of the developing brood as a result of parasitic and predacious insects, so that only about eight percent of the maximum brood ever reach maturity and emerge. In addition to this mortality, there is what has been called a flight mortality caused by birds and mammals, which feed on the beetles as they migrate from one tree to another. So it is very seldom that we ever have an increase in an infestation amounting to more than 250 or 300 percent, or two or three trees attacked this year for each one attacked last year.

DO WE ALWAYS HAVE INFESTATIONS OF THESE BEETLES?

As the mountain pine beetle is indigenous to this country, they are always present within our forests. Under normal conditions they occur in what has been called a normal or endemic infestation. Such conditions exist when all of the different elements of nature are so balanced one against another that one insect cannot maintain supremacy over its enemies for any great length of time. This condition is called a biological balance, and applies to all animal life. From time to time these normal infestations increase into destructive epidemics. Such abnormal conditions are the result of the failure of certain factors which have previously contributed toward holding the injurious insect in check. It is often difficult to isolate the exact cause of such outbreaks, as there are a number of such environmental factors. Some of the most important may be listed, as precipitation, temperature, predacious and parasitic insects, and abnormal quantities of attractive host material, such as blow-downs, slashings, etc. Therefore, the above question can be answered by saying that though we always have what is called a normal loss of timber by the mountain pine beetle we do not always have epidemics.

HOW LONG DO EPIDEMICS LAST?

The answer to this question is indefinite. Insect epidemics last as long as there is a supply of host material remaining, or until nature restores a proper balance of the different factors involved. Some outbreaks are relatively short-lived, while others last for many years.

CAN EPIDEMICS OF THIS INSECT BE PREVENTED?

Though perhaps epidemics of the mountain pine beetle can never be eliminated, their occurrence can be minimized. As the practice of forestry becomes more intensive, and our knowledge of the factors which have a bearing upon these conditions increases, our forests can be kept in a more thrifty growing condition more resistant to insect attack. The prompt harvesting of mature timber will also contribute to the lessening of timber losses as a result of insect attack.

WHAT CAN BE DONE TO PREVENT THESE SERIOUS LOSSES OF TIMBER?

The loss of commercial timber resulting from the attacks of the mountain pine beetle can be reduced to a minimum through the prompt institution of artificial control. Areas of valuable timber must be kept under constant observation, and at the first sign of an increase in the infestation artificial control should be instituted.

CAN TREES BE SAVED AFTER THEY HAVE BEEN
ATTACKED BY THE MOUNTAIN PINE BEETLE?

When a tree has been successfully attacked, it cannot be saved, though its foliage may remain green for some months. The insects have become firmly established beneath the bark, and their removal is impossible.

IF TREES CANNOT BE SAVED AFTER ATTACK,
OF WHAT BENEFIT IS CONTROL?

Artificial control measures are directed toward the destruction of the insect broods beneath the bark of trees which are already killed, to prevent their emergence and attack of other trees.

HOW CAN THIS BE ACCOMPLISHED?

There are a number of direct methods of artificial control, all of which successfully destroy the insect broods beneath the bark. Infested white pine trees are felled, the infested portion of the bole cut into logs, which are decked and burned. If the insect broods are in a larval stage, the peeling of the bark from the infested logs will destroy the insects. Though infested lodgepole pine can be felled, decked, and burned, the most efficient method is to burn them standing. This is accomplished by spraying an inflammable oil upon the trunk of the tree, which is then burned. When trees cannot be burned to the height of the infestation, it is necessary

to fell them for further treatment. Lodgepole pine are usually infested up to a 6-8 inch top diameter, so when trees are not burned to this height, they are felled for subsequent treatment.

IS THERE NOT CONSIDERABLE DANGER IN THE USE OF FIRE?

Care must be exercised at all times in the use of fire in our forests. It is often necessary to close control operations or change to a peeling method of control. Decks must be properly trenched, and tended until safe. During bad fire weather, decks can be burned at night with a fair degree of safety.

DOES NOT THE USE OF FIRE DESTROY BENEFICIAL INSECTS AS WELL AS THE DESTRUCTIVE PEST?

It is obvious that this is an objection to our present methods of control. To overcome this objection, and to preserve these beneficial insects so as to aid nature in restoring a properly balanced condition within the forest, trees showing a certain percentage of parasitism are left untreated. These are left untreated on the basis that the beneficial insects that are preserved will aid in reducing the epidemic to a normal status.

WHAT IS THE MOST IMPORTANT TASK OF A CONTROL OPERATION?

Spotting is the first and most important step in all bark-bettle control projects. Its importance is twofold, as it demands the location of all infested trees within an area, as well as the proper selection of them for treatment after they have been located. Of the two the latter is perhaps the more complicated. The location of infested or insect-attacked trees is but a mechanical operation, which, if one is alert, can be made 100 percent effective. The problem of determing whether a tree showing the external signs of bark-beetle attack should be marked for treatment presents more serious difficulties. Briefly, it is the duty of the spotters to locate, tag, and map as efficiently and economically as possible all infested trees which require treatment. The importance of this task will be appreciated when it is understood that infested trees missed by spotters become a potential source of reinfestation, which often defeats the purpose of the operation.

HOW ARE SPOTTING CREWS ORGANIZED AND WHAT EQUIPMENT DO THEY REQUIRE?

A six-man spotting crew, consisting of one chief spotter, one compassman, and four spotters is used for the location of infested trees in white pine. Each spotter, including the chief spotter, is equipped with a hand ax and sheath, marking crayon, and sufficient tags and tacks for one day's work. Tags should be at least 3" x 4" in size, and of a bright color (yellow or white), so that they can be seen easily by the treaters.

The compassman is equipped with a standard staff compass, staff, two tally registers, one 5" x 8" tatum holder, map sheet, protractor, and pencil.

HOW DO YOU RECOGNIZE TREES THAT HAVE BEEN ATTACKED BY THE MOUNTAIN PINE BEETLE?

Insect-attacked trees can be recognized by the small pitch exudations (pitch tubes) which form at the mouth of entrance holes, or from boring dust around the base of trees or in bark crevices. When the attack is extremely heavy, the pitch tubes are small or absent entirely, so their presence cannot be depended upon as an infallible guide to infested trees. This condition can be explained by the fact that the flow of pitch through so many entrance holes is not sufficient to form tubes. On the contrary, with light attacks the flow of pitch through the few holes is so strong that attacking beetles are often washed from their galleries. Large pitch tubes are usually, though not always, an indication of pitched-out attack. Fresh woodpecker work is a true indication that there were and possibly are insects beneath the bark. However, it does not prove that the insect is the mountain pine beetle.

In marking trees for treatment one will often be called upon to distinguish the work of the mountain pine beetle from other species of bark beetles, particularly those of the genus Ips. In making such decisions the safest rule to follow is to familiarize oneself with the characteristic gallery pattern of the mountain pine beetle. A point to be remembered is that the egg gallery, or main channel, of mountain pine beetle work is always packed solid with sawdust, except for an inch or two at the upper end, while with Ips species the forked galleries are kept free from sawdust.

There is no infallible rule which can be given for the proper marking of infested trees from external evidence. Such evidence will lead one to trees that have been attacked, but more thorough examinations are necessary to determine if they should be marked for treatment. It will be necessary to examine every infested tree by removing a piece of the bark. If the tree was killed by the mountain pine beetle and there are sufficient of these insects beneath the bark, then it should be marked for treatment, provided it is not a parasite tree which must be left untreated. Mountain pine beetle broods may be found as larvae, pupae, or new adults. Parent adults will be found in the top of the egg gallery. Do not mark trees for treatment on the strength of these old black parent adults alone, as they carry very little, if any, potential danger to green trees adjacent. New adult beetles vary in color, appearing first as pure white to brown and then to dark black prior to emergence.

HOW DO SPOTTING CREWS OPERATE?

Spotting crews gridiron a section, or block, of timber, traveling on a definite compass line. Trails, roads, streams, ridges, etc., can be used for base lines when spotting is being conducted in unsurveyed country or where the timber type is more or less broken into small blocks. As the direction of a strip is reversed, the spotter who was on the outside should return on the inside of the new strip. As strips cross main trails or roads, it is a good plan to fasten to a tree or stump a tag showing the number of the strip. The strip can be identified from spotters' maps, and such information often proves to be of assistance to treating-crew foremen in relocating marked trees.

It is difficult, in fact impossible, to visualize all types of conditions in order to offer tentative solutions. As stated, it will often be necessary for chief spotters to make immediate decisions upon the ground. If one bears in mind that the task of spotting is the location of infested trees for the treating crews, there will be no question but that such decisions will be correctly made. A method of spotting which does not locate such trees so they can be re-located with the least possible effort is in most cases an improper one to use. Good judgment must of course be considered in making all decisions in order that spotting will not be carried to an unwarranted extreme.

The chief spotter is charged with the proper conduct of his crew. He must exercise constant supervision over the compassmen and spotters in order that their work be properly performed. During this project, in an effort to preserve the natural enemies of this insect, infested trees showing a certain percentage of the brood to be parasitized will not be treated. To make these selections properly it will be necessary for the chief spotter to examine all infested trees, as he is responsible for this decision. The chief spotter should keep a record of the infested trees that are not to be treated, and they should be blazed and marked with a large "X." In addition to the supervision of his crew the chief spotter will be charged with the submission of required reports, maps, etc.

The compassman will be responsible for the compass work, pacing of distance traveled, and the construction of a map showing the number and location of all trees marked for treatment.

The usual method employed is for the compassman to proceed slowly until one of the spotters shouts "Bugs," which indicates that he has located an infested tree. The compassman then stops, and if the tree is selected for treatment, calls a number to the spotter, and maps the location. The tree numbers should be consecutive so as to facilitate their location by the treating crews. When a group of trees is located, a circle showing the location of the group and the included numbers, such as 17-24, will be used to show their location. The compassman should progress as slowly as necessary to permit the spotters to examine all trees thoroughly on their strips. When the end of the strip is reached, the compassman offsets four chains, and returns on a parallel strip in the same manner. The inside spotter should always be the man who on the previous strip was on the outside, as he will be familiar with the territory being covered. At the end of the day's work the map constructed should be transferred to what will be the completed map. The number of copies of this map which will be required will vary, though usually there will be one copy for the camp manager, one for each of the treating crews working in the area covered by the map, and one for the office files.

Each spotter is responsible for the examination of all trees on a strip one chain wide on one side of and parallel to the course of the compassman. The two inside spotters guide on the compassman, and the two outside spotters guide on the inside spotters, so that they can maintain a proper alignment or formation. The best results are secured when the crew maintains a slightly V-shaped formation. In this manner the strips are held to a width of one chain, which has been found to be the maximum width that can be covered if every tree is examined properly. The need for examining every tree has been explained under the heading "How do you recognize

trees that have been attacked by the mountain pine beetle?" When an infested tree is selected for treatment, the spotter fastens a tag, on which is written the tree number given him by the compassman and his own initials, to the tree by tacking the two upper corners. In addition to the tag a blaze is placed on the opposite side of the tree, on which is also written the tree number and the spotter's initials.

The chief spotter works over the entire four-chain strip behind his crew, and is responsible for the alignment of his organization, the correct marking of all trees for treatment, and in fact the entire activity of the crew. In this way he is able to supervise the men properly, and it is only through efficient and adequate supervision that effective spotting can be secured.

It is often erroneously assumed that the presence of red-tops can be used as a guide to locate new attacks, and that it is not necessary to cover the entire area. This is an improper belief, as such a procedure will not locate new spots of infestation where there is no discolored foliage.

IS TREATING AN IMPORTANT OR DIFFICULT TASK?

Treating is an important phase of control, and its efficiency will have a direct bearing upon the success of the project. Obviously there would be no need to mark an infested tree for treatment if it is not to be properly treated. Poor deck construction is one of the most common causes of improper and expensive treating, and results in subsequent reinfestation. Care must be exercised in the location of log decks so that green trees will not be scorched. Fire-injured trees are highly susceptible to future beetle attack. Stumps must always be peeled. When trees are burned standing, they must be burned to the height of infestation or felled for subsequent treatment. Thorough treatment of marked trees is essential.

HOW DO TREATING CREWS OPERATE AND WHAT EQUIPMENT IS REQUIRED WHEN TREES ARE FELLED AND BURNED?

Treating crews will consist of six men, which include a crew leader, two sawyers, and three swampers. Each treating crew foreman will have charge of two such crews, and will be responsible to the Camp Superintendent for their work. Sawyers are equipped with a 5-1/2-foot crosscut saw, two small felling wedges, and a double-bitted ax, while each swamper carries an ax and a canthook.

Treating crews under each foreman must not work so close together that they interfere with each other, nor so far apart that adequate supervision on the part of the foreman is difficult. The crew foreman uses the spotter's map to re-locate the trees marked for treatment, and directs his crew leaders to them. He must plan the day's work so that there will be the least possible time lost in traveling from one infested group of trees to another. The foreman is responsible for treating all trees

marked for treatment, as well as the proper burning of the log decks. When trees are located that have been missed by the spotters - that is, infested trees that have not been marked for treatment or marked to be left as parasite trees - they will be treated and listed as extra trees.

The sawyers are charged with the removal of spotters' tags from trees treated, and with marking the tree number upon the stump, which provides a means of checking if necessary. The tags are turned over to the treating-crew foreman, who in turn passes them on with his "Crew Foreman's Daily Report" to the Camp Superintendent.

While the first tree is being felled, the swampers prepare a place for the log deck, which must be of sufficient distance from green trees to prevent scorching. When the deck location is selected, dry poles or limbs should be placed flatly upon the ground. When the trees are felled and cut into convenient, uniform lengths, the swampers roll them onto the dry material, packing them as closely as possible, so that no large holes or spaces occur either on the deck or under it. Decks must not be piled crosswise on skids. This leaves a space between the deck and ground, and as soon as the dry material burns up, the fire will almost invariably go out.

After the sawyers have finished a group of infested trees, they go to the next as directed by the foreman. The swampers will remain and complete the decking and preparations for burning by piling dry limbs and slash around small decks to assure a good burn. Fire should be started at the lower end of all decks. Stumps must be peeled. If any fire hazard exists, all decks must be trenched, and no fires started until late in the afternoon or at some time when conditions are more favorable. When decks are not burned as constructed, they must be tagged in the same manner as an infested tree. The crew foreman must also construct a map showing the location and the number of each unburned deck. The tag is placed on a nearby tree, and is collected by the work supervisor when his inspection shows that a complete burn of all infested material has been accomplished.

After a deck of infested logs has been fired, it must be tended regularly until all infested bark surface has been burned. One man is usually detailed to watch several decks, and he rolls unburned portions of logs together before the fire burns out. It is best to fire large decks late in the afternoon, as they will burn all night and there will still be enough fire left the following morning with which to burn the unscorched portions of the logs. As smaller decks burn much faster and need more attention, it is best to fire them in the morning in order that they can be tended during the afternoon.

During seasons of relatively high fire hazard, night burning must be resorted to. Decks are built and trenched by treating crew during the day, but are burned during the night by two or three men. Fires are started about 7 o'clock in the evening, and are watched all night. By rolling the burning logs together, the fire is fairly safe by morning, and with care there will be no danger of the fire spreading. However, such decks must be watched during the following day or until the fire is out.

WHAT SORT OF AN ORGANIZATION IS REQUIRED WHEN TREES ARE BURNED STANDING?

When trees are burned standing, the spotting and treating are performed by the one operation. The spotting crew operates as before, but does not mark the trees for treatment. The oil, spray tanks, and felling tools are carried behind the crew by pack horses, so that when infested trees are located the equipment is brought up and the trees treated at once.

WHEN DO THESE BEETLES ATTACK?

In white pine there are three general attack periods: the first in June; the second and main attack from the middle of July to the middle of August; and the last from late August to the end of the season. Approximately one year is required for each of these broods to develop; consequently, the new adults from these three attack periods emerge about a year later during the same period. The June brood pass the winter as new adults; the midseason and most numerous brood over-winter principally as large larvae; while the late brood pass the winter as small larvae and eggs. In addition to their original attacks, the parent adults re-emerge and make a second attack, nearly always on new trees. The second attack occurs approximately 20 days after the first, so with each attack period there are both new and parent adults from the previous period working together.

Practically the same conditions exist in lodgepole pine, though there are not very many over-wintering new adults, which limits the number of June attacks; in fact, these are rather uncommon.

WHY CAN WE NOT SECURE ANOTHER INSECT WHICH WOULD DESTROY THE MOUNTAIN PINE BEETLE?

The above question, which is a perfectly logical and popular one, is always asked by those who are not familiar with insect life. This question is prompted by the knowledge that all insects, both injurious and beneficial species alike, have their own parasitic and predacious insect enemies. For example, the parasitic enemies of the mountain pine beetle are also preyed upon by other insects. Such an arrangement is necessary in order to prevent the parasites from eliminating the mountain pine beetle, which would be followed by the complete destruction of the parasites, as there would be no mountain pine beetles for them to feed upon. Likewise, if there were no parasites of the mountain pine beetle, this injurious pest would soon increase to such numbers as to destroy all of our pine. This arrangement of beneficial and injurious insects is nature's method of maintaining all of the different factors of a forested area in a properly balanced condition.

The use of parasitic or predacious insects in the control of an injurious pest is termed biological control. In the practicing of biological control, the entomologist has two possibilities, which are the utilization of local beneficial insects or the importation of such beneficial species from foreign territories. With the first possibility we attempt to administer our control methods in such a manner as to preserve as many beneficial

insects as possible. In white pine control work we do not treat those infested trees which show a certain percentage of the brood to be parasitized. We believe that by leaving these parasites they will increase to such numbers as to gain the upper hand of the injurious insect and restore conditions to a proper balance. To go further than this and to develop one of the native parasites to such an extent that they will completely control an outbreak of the mountain pine beetle seems to be impossible, as it would be necessary to eliminate all of the enemies of such a parasite to permit it to develop unhampered.

In considering the second possibility, or the introduction of parasites from a foreign territory, it is of course necessary to have some place to go to secure your parasites. The mountain pine beetle is a native of the northwestern United States and Canada. It is found in no other place in the world. Therefore, we have no place to go to secure parasites which are not already in this region. The introduction of parasites for the control of insects which are indigenous, or native, to a territory, though perhaps not impossible, offers many difficulties. The only successful cases of control by parasites has been against injurious pests introduced into territories foreign to their native home. Then it is possible to go to the original home of the injurious pest and collect some of its most important parasites. These can be carefully collected so that their enemies are left behind. In this way some very successful examples of control by parasites have been effected. However, in all instances they were against introduced insects. Therefore, it would seem that all we can do in attacking epidemics of the mountain pine beetle is to so direct our control measures as to preserve as many parasites and predacious insects as possible as a means of helping them restore conditions to a proper balance.